GUIDE

TO THE

COLLECTION OF FOSSIL FISHES

IN THE DEPARTMENT OF

GEOLOGY AND PALÆONTOLOGY,

BRITISH MUSEUM (NATURAL HISTORY),

CROMWELL ROAD, SOUTH KENSINGTON,

LONDON.

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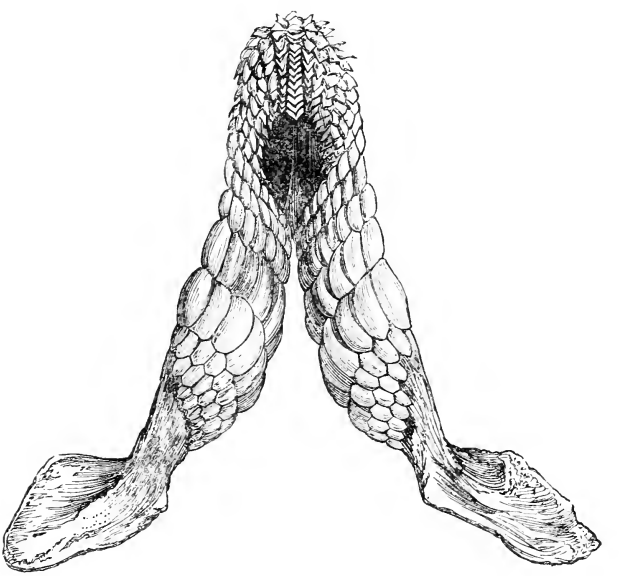

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NOTE.—Figs. 2, 3, 4, 5, 8, 19, 20, 22, 23, 28, 30, 41, 42 have been engraved expressly for this guide.

Figs. 35, 38, 39, and 40 have been presented by H. M. Stationery Office (from Decade X. of the Memoirs of the Geological Survey of the United Kingdom).

Figs. 27, 29, 31, and 36 have been presented by Mr. John Murray.

Figs. 9, 10, 12, 14, 18, and 24 have been presented by Dr. H. Woodward.

The remaining 31 illustrations have been supplied by Messrs. A. and C. Black; Messrs. William Blackwood and Sons, Messrs. Cassell and Co., Messrs. C. Griffin and Co., and Messrs. Macmillan and Co., from the various works published by them.

INTRODUCTION.

The accompanying Guide to the Collection of Fossil Fishes in the British Museum of Natural History has been prepared in the hope that it may be found useful alike to the geologist and the palæontologist.

It has been found more convenient to arrange the Collection zoologically, rather than stratigraphically, yet every specimen bears upon its label not only its name, but also the Formation and locality whence it was derived.

Moreover the fishes of the older rocks nearly all belong to families and genera which are now quite extinct. The Chondropterygii—Sharks and Rays—however, offer a remarkable exception, being an order of Fishes whose persistence in time probably exceeds that of any other vertebrate type ; whilst in the Dipnoi, one family, at least—the *Ceratodi*—has come down to our time from the Devonian epoch, apparently but little modified* in the long lapse of geological ages.

References will be found, at the end of the Guide, to the various works in which figures and descriptions are given of specimens preserved in the Collection, and which are the "types," that is to say, the specimens, on which the genus or species was founded.

The student or visitor who desires intelligently to study the Fossil Fishes in this Gallery will find it indispensable to combine with it a careful examination of the fine collection of living Fishes, prepared and mounted for exhibition in the first North-Western Gallery of the Zoological Department, on the other side of the Great Hall.

The Collection of Fossil Fishes is exhibited in Gallery A, the first of the wide North-Eastern Galleries, leading from

* Only the teeth of these fishes have been preserved in a fossil state.

Gallery D, in which the Fossil Reptiles are placed. It contains thirty-two Table-cases and about 260 feet linear of Wall-cases.

Here are exhibited the finest collection of Fossil Fishes ever brought together in any Museum. This Class was always well represented in the Department, but it has lately received two splendid additions, by the acquisition of the famous collections of the Earl of Enniskillen, D.C.L., F.R.S., from Florence Court, Enniskillen, Ireland; and that of the late Sir Philip de Malpas Grey-Egerton, Bart., F.R.S. (Trustee of the British Museum), of Oulton Park, Tarporley, Cheshire; both obtained by purchase in the year 1882, and whose incorporation has only now been accomplished (1884).

These collections, together with those of the late Dr. Mantell, F.R.S., and Mr. Frederick Dixon, F.G.S., previously acquired, with other minor but valuable donations and purchases, now include the majority of the figured types of Agassiz's British Fossil Fishes from his great works, "Recherches sur les Poissons Fossiles" (Neuchatel, 1833–43, 4°, and Atlas, folio); and his "Monographie des Poissons Fossiles du Vieux Grès Rouge, ou Système Dévonien" (Neuchatel, 1844, text 4°, folio plates).

The Gallery has been still further enriched by the purchase of the very numerous and beautiful specimens of Fossil Fishes from the Cretaceous Limestone of Hakel and Sahel-el-Alma, in the Lebanon, obtained through the persevering and energetic labours of the Rev. Prof. E. R. Lewis, M.A., F.G.S., of the Syrian Protestant College, Beirût.

Arrangement.—The Collection, which contains about 450 genera, and 1250 species, commences on the left hand on entering the Gallery, the Wall-cases being used for the larger specimens, whilst the smaller are arranged in the nearest Table-cases.

The names of the orders and families are printed in bold and conspicuous type and repeated in each Case, and those of the genera being also repeated upon smaller labels.

Every specimen bears, in addition to the genus, species, and author's name, the name of the Formation and the locality from which it was obtained: and, if presented, the name of the donor.

Every "type-specimen" is distinguished by a small disk of green paper affixed to it; and upon the label is a reference to the work in which such "type-specimen" has been figured and described.

It is only proper to state here that this Gallery has been entirely arranged by Mr. William Davies, F.G.S., with the assistance of Mr. Arthur Smith Woodward.

Mr. William Davies has devoted upwards of twenty-five years to a careful study of the Fossil Fishes in the Collection, and the writer is indebted to him for many facts and observations embodied in the following pages.

He must further acknowledge his indebtedness to Dr. R. H. Traquair, F.R.S., for much valuable help derived from the Notes of his "Swiney Lectures" on Fishes, delivered at the Natural History Museum, in June 1883; also to Dr. Albert Günther, F.R.S., Keeper of the Zoological Department, from whose work, "An Introduction to the Study of Fishes" (1880), he has made copious extracts.

HENRY WOODWARD.

Department of Geology,
January, 1885.

FOSSIL FISHES.—GALLERY A.

As the varied layers of sandstone, limestone, and clay, which compose the greater part of the superficial crust of the earth, have been accumulated as sedimentary deposits in lakes, estuaries, and seas, one would naturally expect that, of the Vertebrate division of animals, the remains of Fishes would be most frequently met with in these formations; and such is in fact the case, although from their fragmentary condition, it is not always possible to determine their precise systematic position.

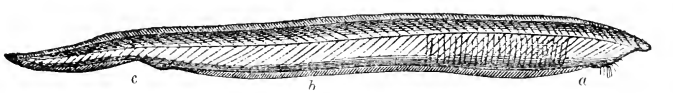

FIG. 1.—The "Lancelet," *Branchiostoma lanceolatum* (recent). *a*, Mouth; *c*, vent; *b*, abdominal pore.

Some fishes have no hard structures which could be preserved in a fossil state. Thus, for instance, the simplest or most lowly organized of fishes at the present day, the "Lancelet" (*Branchiostoma*), has only a membrano-cartilaginous skeleton without vertebræ, ribs, or jaws. (Fig. 1.) If in past geological times fishes of similar

FIG. 2.

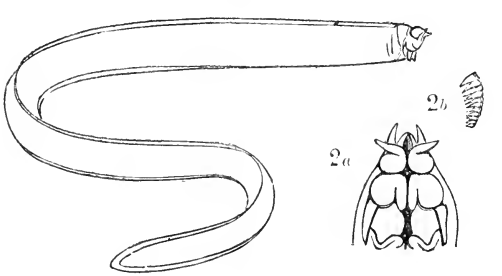

FIG. 3.

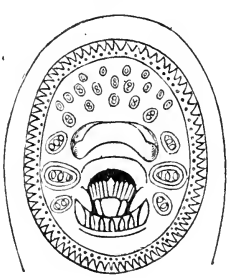

FIG. 2.—The "Hag-fish," *Myxine australis* (recent). 2*a*, Lower aspect of head. 2*b*, A single detached tooth of *Myxine*.
FIG. 3.—Mouth of Lamprey, *Petromyzon fluviatilis*, showing circular arrangement of teeth.

structure existed, they would leave no remains which could have been preserved to us.

Another group (the *Cyclostomata*), having also a notochordal, cartilaginous skeleton, may perhaps, like the "Lancelet," have been present amongst the earliest living forms. The only hard structure which they possessed consisted of minute horny denticles with which the mouths of some of them were armed. Small serrated bodies, having some resemblance to the horny dental plates of the "Hag-fish," *Myxine* (Fig. 2), have been met with in the Cambro-Silurian and Devonian formations of Russia, England, and North America (Table-case No. 25); they are called "Conodonts" (Fig. 4), and may perhaps attest the occurrence of these simple

FIG. 4.—"Conodonts" from the Cambrian (after Dr. G. J. Hinde). × 10 times.

Cyclostomatous fishes in the lower Palæozoic rocks.* The earliest evidence of fossil fish-remains, other than "Conodonts," is that of a single head-shield of *Scaphaspis ludensis*, from the Lower-Ludlow Rock, of Leintwardine, Shropshire; discovered by Mr. J. E. Lee, F.G.S.; the next is met with in the Ludlow "Bone-bed" in the Upper Silurian Formation (Table-case No. 25). This thin layer consists of fragmentary fish, crustacean, and other remains amongst which have been detected small, compressed, slightly curved, and ribbed fish-spines, named *Onchus*, and some minute shagreen-scales, called *Thelodus*, and part of a jaw-like organism, with pluricuspid teeth, named *Plectrodus*, likewise the head-shields of a species of *Scaphaspis*, and other similar fragmentary remains.

The spines and scales may have belonged to one of the Plagiostomatous fishes, such as the Sharks or Rays.

Passing over the first and second sub-classes (I. LEPTOCARDII and II. CYCLOSTOMATA—the latter of which is only doubtfully represented by the above-mentioned bodies known as "Conodonts") —we arrive at the third great sub-class, the PALÆICHTHYES, embracing all the more ancient fossil fishes; subdivided into the *Chondropterygii*, comprising the Sharks, Rays, and Chimæras; and the *Ganoidei*, embracing the great majority of the fossil fishes whose remains are met with in the Palæozoic and Mesozoic formations.

The latter are characterized by their highly enamelled scales or by the head-shield and bony-plated cuirass with which some of them are covered.

The fourth great sub-class, named the TELEOSTEI, includes all those fishes with a true bony skeleton. It is in this division that most of the Tertiary and existing species of fishes are placed.

* *See* Dr. G. J. Hinde's paper in *Quart. Journ. Geol. Soc.*, 1879, Vol. XXXV., pp. 351-369, Pls. xv. xvi. and xvii., on Cambro-Silurian and Devonian Conodonts.

SUB-CLASS III. PALÆICHTHYES.

Order I.—Chondropterygii (Sharks, Rays, Chimæras).

Sub-order I.—Plagiostomata.

Selachoidei—Sharks.

Wall-cases 1, 2, 3, and Table-cases 25 to 33.—In these fishes the skeleton is cartilaginous, the skull consists of a simple box, the separate parts of which are not indicated by sutures; the teeth are very varied in form and consist of vaso-dentine, they are fixed in rows and by ligament to the cartilaginous jaws. The backbone is sometimes composed of distinct vertebræ, but is frequently cartilaginous or notochordal. The gills are pouch-like and open on the surface as a series of separate clefts or apertures, placed on the sides of the neck in the Sharks, and beneath the body in the Rays. The gill-openings have no external gill-cover or operculum, nor are there any branchiostegal rays. The body is provided with median and paired fins, the hinder pair being abdominal.

The skin is usually covered, more or less closely, by numerous small detached plates or granules of dentine, with tubercles or spines (Fig. 22) scattered over the whole surface of the integument;

FORMS OF TAILS OF FISHES.

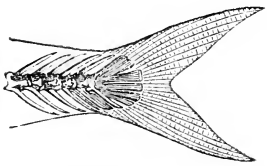

Fig. 7.—Homocercal.* Modern form.

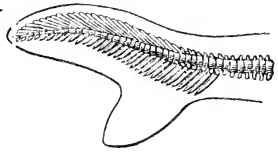

Fig. 6.—Heterocercal.† Ancient form.

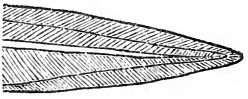

Fig. 5.—Diphycercal.‡ Primitive form.

when very small and close-set, as in the Dog-fish and the Shark, this dermal covering is called "shagreen." The denticles agree closely in microscopic structure with true teeth.

In the majority of the Chondropterygians the extremity of the vertebral column is bent upwards and continued along the upper lobe of the tail-fin, which is usually considerably prolonged, hence called "heterocercal" (Fig. 6); only a few, like *Squatina* and some Rays and Chimæras, possess a "diphycercal" tail, in which the fin is equally developed on both sides of the vertebræ, forming a simple pointed caudal fin (Fig. 5), as in the "Mud-fish," *Protopterus*.

In most modern fishes, such as the Mackerel, Herring, and Salmon, the tail is "homocercal," the fin-rays being equal-lobed both above and below the vertebræ (Fig. 7).

Of these three forms there can be no doubt that the Diphycercal

* *Homocercal*, equal-lobed tail-fin. † *Heterocercal*, unequal-lobed tail-fin.
‡ *Diphycercal*, double tail-fin.

embryonic tail is the primitive type from which the ancient heterocercal and the more modern homocercal forms have been developed.

As the skeleton in all the earlier Sharks was cartilaginous like

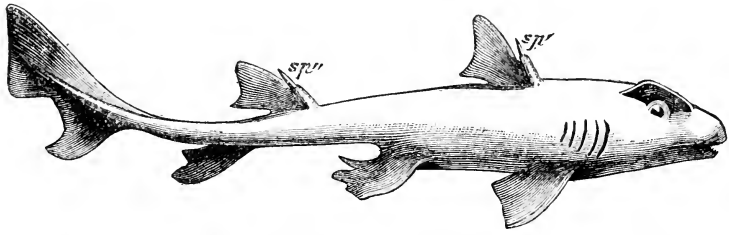

FIG. 8.—Port-Jackson Shark, *Cestracion galeatus*, Australia (recent). *sp'*, Anterior dorsal spine; *sp''*, posterior dorsal spine.

their modern representatives, and in many of them even notochordal, it is not usually preserved; there is often therefore great difficulty in obtaining satisfactory evidence for the correct deter-

FIG. 9.

FIG. 10.

FIG. 9.—Posterior spine of Cestracion (recent) from Japan.
FIG. 10.—Spine of *Chimæra monstrosa*, Linn. (recent), Norway, showing the broadly-expanded base of spine (*b*), which is inserted in the muscular tissue.

mination of some of these older fishes in a fossil state. Thus in the great majority of instances we have only the detached spines, teeth, and shagreen left, all else has disappeared;* but in the

* In consequence of this, many genera of fossil sharks and very many species are based solely upon detached spines or teeth, whilst of the rest of the fish we know absolutely nothing.

Lithographic stone of Solenhofen, Bavaria, and in the Cretaceous rocks of the Lebanon, Syria (*See* Wall-case 3, and Table-cases 31 and 33), some specimens have been met with showing the entire outline of the fish very perfectly, and many of the details of their anatomy.

Wall-case 1 and Table-case 25 contain a large series of "Ichthyodorulites," a term usually applied to the strong bony defensive spines of extinct Shark-like fishes. (See Figs. 9–13.) These spines

Fig. 11.

Fig. 12.

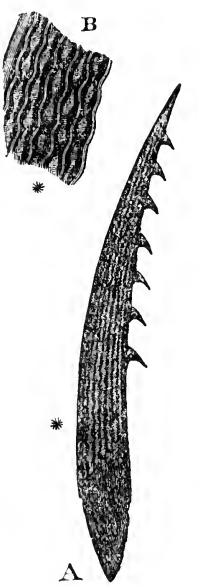

Fig. 13.

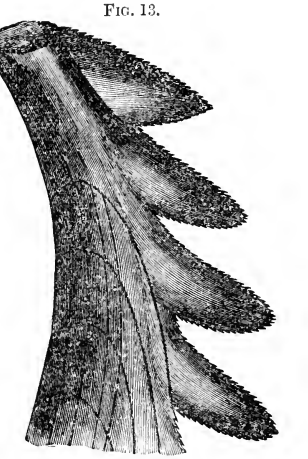

Fig. 11.—Dorsal spine of *Hybodus*, Lias, Lyme Regis.
Fig. 12.—A. Spine of *Lepracanthus Colei*, Owen, Coal-measures, Ruabon, N. Wales. B. A portion of the spine enlarged, to show the external ornamentation.
Fig. 13.—Portion of spine of *Edestes vorax*, Coal-measures, Indiana, U.S. N. America.

were firmly embedded in the muscular tissue of the back, just in front of the dorsal fins.* That they were formidable weapons of offence and defence, is clearly indicated by the pointed extremity and the presence of one or two rows of strong recurved denticles on the posterior margin, adapted for inflicting deep and lacerating

* Save in *Gyracanthus* and *Oracanthus*, which were, no doubt, lateral spines.

wounds. With the exception of that portion of the base of the spine inserted in the body, which was smooth, the external surface is enamelled with "ganoine" and is always more or less highly ornamented or sculptured with longitudinal ridges, striæ or tubercles (as in *Ctenacanthus*, etc.), or transversely and spirally decorated (as in *Gyracanthus*). The spines of *Gyracanthus* are unsymmetrical in form and worn down at their extremities. They were no doubt attached to the pectoral fins.

The spines of *Edestes* (Fig. 13) are so strongly serrated as to have led their first discoverer (Prof. Leidy) to conclude that they were part of a fish's jaw with teeth. The series of "Ichthyodorulites" in Wall-case 1 has all been derived from the Carboniferous Limestone and from the Coal-measures.

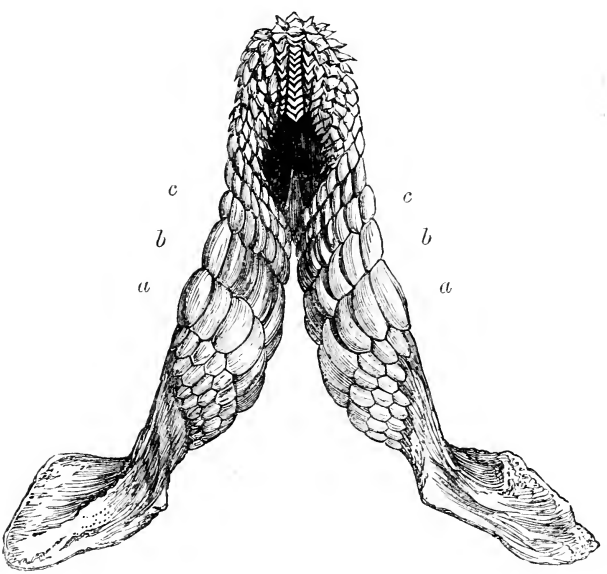

FIG. 14.—Upper jaw of Port-Jackson Shark, *Cestracion Philippi* (recent), showing variation in forms of teeth in same jaw.

In the Carboniferous Limestone and Coal-measures we also find an immense variety of forms of palatal teeth with which the mouths of these ancient Selachians were armed, like that of the modern *Cestracion Philippi*.

The existence at the present day of the *Cestracion Philippi*, commonly known as the 'Port-Jackson Shark,' has been of the greatest assistance to palæontologists, for it has thrown the most important light upon the detached fossil teeth which are so frequently met with in strata of Cretaceous, Jurassic, and Carboniferous age.

The dentition of *Cestracion* (Figs. 14 and 15) shows it to have been admirably fitted for the prehension and mastication of Crustacea and Mollusca; the teeth are seen to be arranged in oblique rows upon the cartilaginous jaws and to vary greatly in character between those forming the anterior series, which consists of sharp-

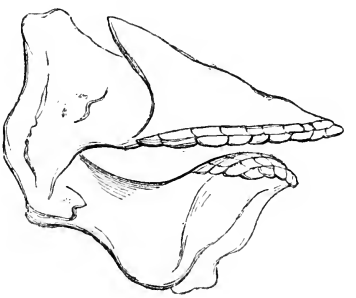

Fig. 15.—Side-view of jaws of Port-Jackson Shark, *Cestracion Philippi* (recent).

pointed teeth modified for seizing and holding their prey, and the lateral series, which is well adapted by their flattened form for crushing the shells of Mollusks and Crabs.

These lateral teeth also vary greatly in the several rows (see Fig. 14, *a*, *b*, *c*), covering the two rami of each jaw, and they enable the palæontologist clearly to understand that many so-called species founded on different forms of fossil palatal teeth found detached from one another, may, after all, have really belonged to different parts of the mouth of one and the same individual species of Shark.

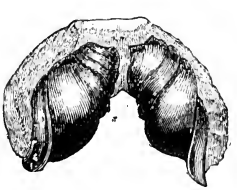

Fig. 16.—Teeth of *Cochliodus contortus*, Carboniferous Limestone, Armagh.

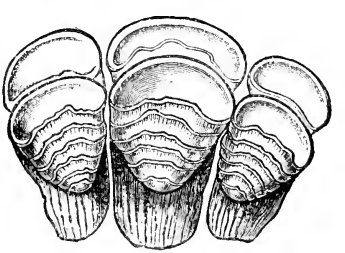

Fig. 17.—Some of the central teeth of *Janassa linguæformis*, Coal-measures.

The two dorsal fins also were each armed with a short but strong spine. Similar spines are frequently met with in the same series of deposits in which the palatal teeth have been discovered.

Table-cases 29, 30, and 32, well illustrate the modifications of form observable in the teeth of such genera as *Psephodus*, *Orodus*, *Streblodus*, *Cochliodus* (Fig. 16), *Sandalodus*, *Psammodus*, *Petalodus*,

Janassa (Fig. 17), etc. As their jaws were only cartilaginous, they perished and the teeth are usually met with singly, so that their correlation with each other and with the spines is always difficult.

Nevertheless, the spines of *Pleuracanthus* and the teeth of *Diplodus* (Wall-case 3 B, and Table-case 32), from the Coal-measures, are now found to belong to one fish; the spines of *Ctenacanthus* (Wall-case 1, and Table-case 25), and teeth named *Cladodus* (Table-case 27), from the Carboniferous Limestone, are also now correlated by some authors.

In Wall-case 2, and Table-cases 27, 28, and 30, is arranged a fine series of remains of heads with the teeth, spines, and shagreen, of *Hybodus* (Fig. 11) and *Acrodus* (Fig. 18), the sharks of the Lias formation.*

In addition to the dorsal fin-spines, of which these genera possessed two, like the recent Port-Jackson Shark, they were also provided with four curious recurved hooklets (called by Agassiz *Sphenonchus* (*See* Table-case 28). They have a large bony base which was imbedded just above the eye on each side of the head, and a second pair a little further back.

The entire series of teeth in both *Hybodus* and *Acrodus* is known (*See* Wall-case 2, and Table-cases 28 and 30); they present a most remarkable variation in form, between sharply-pointed cuspidate teeth in front, and flatter grinding teeth at the sides of the jaws (Fig 18).

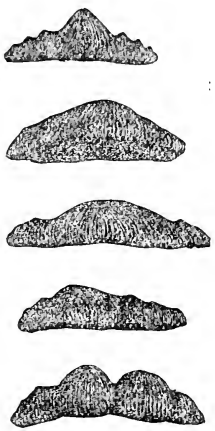

Fig. 18.—Teeth of *Acrodus*, Lias, Lyme Regis. Five palatal teeth, showing variation in form.

We fortunately know also the nearly perfect jaw of *Strophodus* (*See* Table-case 31), from the Oolite of Caen, Normandy, showing about sixty teeth in their true relation to each other, and exhibiting the same great variation in form, which, if found separately, might have led to their being referred to distinct species.

It is interesting to notice also the variation in the number of teeth in the jaws of these ancient Cestracionts.

Thus *Plethodus* (Table-case 31), from the Chalk of Sussex, appears to have possessed only one tooth in each jaw; *Ptychodus*, also from the Chalk (Table-case 31), has been found with as many as 200 associated teeth. *Streblodus* and *Cochliodus*, from the Carboniferous Limestone, had only two or three teeth on each side† (Table-case 29).

* These forms range upwards in diminished numbers to the Chalk formation.

† But many of the palatal teeth of the Carboniferous Limestone which bear separate generic names, may, when we know more of their true nature, be shown to belong to one and the same fish, as is seen in the case of *Strophodus*, *Acrodus*, and *Hybodus*, and in that of the modern *Cestracion*.

Sandalodus, from the Carboniferous Limestone (Table-case 29), had probably only one very large tooth on each side of its upper and lower mandibles, or four in all.

TEETH OF SHARKS.

Fig. 19.—Tooth of *Lamna elegans*, Agassiz, London Clay.

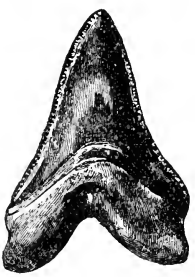

Fig. 20.—Tooth of *Carcharodon megalodon*, Agassiz, Suffolk Crag.

The *Carchariidæ*, *Lamnidæ* (Fig. 19), and *Notidanidæ*, characterize the Cretaceous and Tertiary formations. A fine series of the teeth of these sharks is displayed in Table-cases 26 and 27.

Noteworthy amongst these are teeth of the genus *Carcharodon* (Fig. 20), Table-case 26, which greatly exceed in size those of any

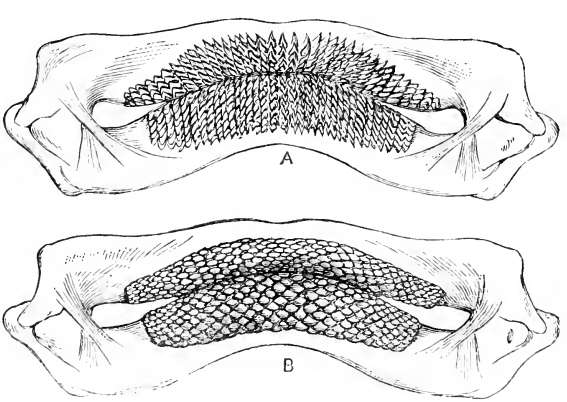

Fig. 21.—Jaws of Male (A) and of Female (B) Skate, *Raja clavata*, showing the remarkable variation in the dentition which they exhibit.

living species of Shark. They are very widely distributed, being met with in Tertiary strata in New Zealand, Jamaica, S. Carolina, in Egypt, Malta, and in the Antwerp and Suffolk Crags.

It is interesting to notice that in some places, both in the Atlantic and Pacific (especially at extreme depths in the red-clay areas), the

"Challenger" records state, that many teeth of sharks and ear-bones of whales were dredged up, all in a semi-fossil state, and usually impregnated with oxides of iron and manganese. The sharks' teeth belong principally to genera, and often to species, believed to be extinct, and resemble those found fossil in the late Tertiary formations.*

In Wall-case 3 are placed a fine series of Sharks and Rays (Figs. 21–23) from the Cretaceous of the Lebanon. These specimens are so beautifully preserved that the entire outline of the fish, the teeth *in situ*, the shagreen skin, and the form of the fins and tail, are often seen. The Sharks probably belong to the genus *Scyllium*, and closely resemble the small living Spotted Dog-fish in form (Wall-case 3, and Table-case 27).

The genus *Spinax*, from the Lebanon Cretaceous, exhibits the vertebræ and two dorsal spines *in situ* (Table-case 31).

Specimens of *Drepanephorus canaliculatus*, from the Chalk of

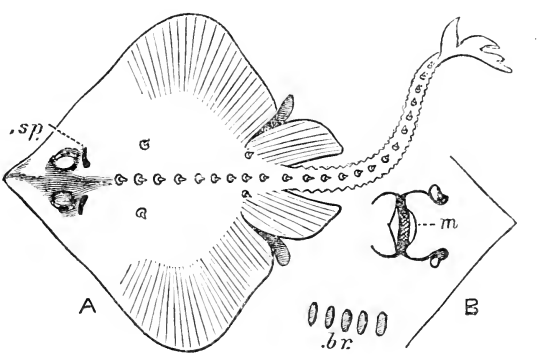

FIG. 23.—The Ray (*Raja Merrayi*, Günther), from Kerguelen's Island. A, dorsal aspect; B, part of ventral side; *sp*, spiracle; *br*, branchial clefts.

Sussex, show the spines, vertebræ, jaws, and teeth in natural association (Table-case 31).

In the same Wall-case (3) are placed specimens of the remarkable *Squaloraia polyspondyla*, from the Lias of Lyme Regis—also numerous examples of the Ray family (Fig. 23), represented by *Spathobatis bugesiacus*, from the Kimmeridgian of Cirin, near Lyons; *Squatina acanthoderma*, from the Lithographic stone of Bavaria; *Cyclobatis* and *Rhinobatus*, from the Cretaceous of the Lebanon. These latter are among the most perfect examples of fossil fishes in the collection; the broadly-expanded rayed pectoral fins and the long caudal fin are well seen.

The spines known as *Myriacanthus* (Table-case 33), from the Lias, are referred to the Raiidæ.

* "Voyage of H.M.S.S. *Challenger*," by Sir Wyville Thomson, 1877, Vol. II. pp. 351 and 376.

Batoidei.—Rays.—In Table-cases 32 and 33, are seen a most interesting series of remains of fishes of this family, comprising sets of the tessellated palatal teeth of *Myliobatis* and *Ætobatis*, from the Eocene Tertiary formation. These "Sea-devils," or "Eagle-Rays," are amongst the largest of living fishes, one taken at Messina weighing as much as 1250 lbs.; those met with off Barbadoes being still larger. One captured at Jamaica measured 15 feet in breadth and as much in length, and was four feet in thickness (Günther). The same case contains specimens of the curious prickles of the "Thornback," *Raia antiqua* (Fig. 22), from the Norwich Crag, etc.; and portions of the toothed rostral bone of the "Saw-fish," *Pristis*, from the Middle Eocene of Bracklesham, Sussex.

Fig. 22. — Dermal Spines of the Thornback, *Raja clavata*.

Sub-order II.—Holocephala.

Chimæroidei.

The Chimæras resemble the Sharks in many important points of structure. The skeleton is cartilaginous and notochordal, the sheath presenting however numerous calcified rings. The first dorsal fin has a powerful spine attached to its base. The teeth consist of four dental plates above and two below.

They are represented in Table-cases 33 and 34, by numerous jaws of *Elasmodus* and *Edaphodon* from the Eocene; the latter genus also occurs in the Gault, Greensand, and Chalk; and *Ischyodus* from the Gault, Greensand, and Oolite (Table-case 34), and *Ganodus* from the Great Oolite, Stonesfield.

There is little doubt that the spines known under the name of *Leptacanthus*, found in the same matrix with Chimæroid jaws, from the Chalk to the Lias, belong to one and the same fish.

Other remains of Chimæroids may be seen in Wall-case No. 3c.

Order II.—Ganoidei ?*

Sub-order I.—Acanthodini.

The Acanthodians form an interesting group of very small or moderate-sized Palæozoic fishes characterized by the presence of

* We have felt some doubt as to the propriety of placing the *Acanthodini*, the *Placodermata*, and the *Dipnoi*, under the order Ganoidei: from the observations of Prof. Huxley, Dr. R. H. Traquair, and others, it seems quite probable that these ancient types of fishes, when better understood, may hereafter form more than one distinct order.

strong defensive spines in front of the paired and median fins, but not in front of the caudal fin. They have minute rhombic enamelled scales, ornamented in some species by fine striæ. From the similarity of form of the dorsal spines and their mode of implantation; the small and shagreen-like scales, which scarcely

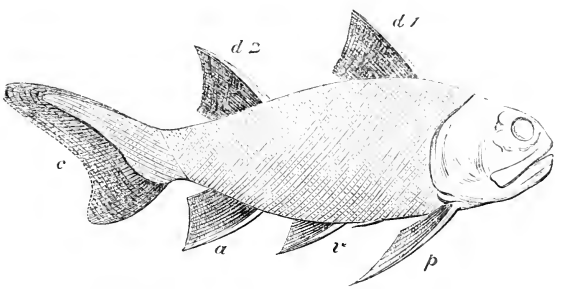

Fig. 25.—*Diplacanthus striatus*, Old Red, Cromarty. *d* 1, First dorsal fin; *d* 2, second dorsal fin; *p*, pectoral fin; *v*, ventral; *a*, anal fin; *c*, caudal fin. Each fin has a strong defensive spine in front.

overlap, the cartilaginous skeleton, and naked branchial arches, they are considered by some ichthyologists to occupy a position intermediate between the *Plagiostomata* and the *Ganoidei* (Table-case 34).

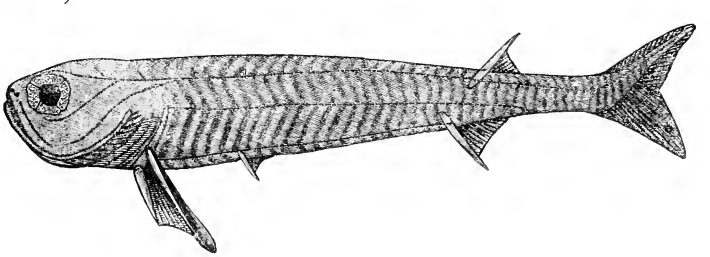

Fig. 24.—*Acanthodes*, sp. (restored figure, after Kner and Roemer), Permian.

They are represented by *Diplacanthus* (Fig. 25), *Cheiracanthus*, *Climatius*, *Euthacanthus*, and *Parexus*, from the Old Red Sandstone, and *Acanthodes* (Fig. 24), ranging from the Old Red to the Permian.

Sub-order II.—Placodermata.

The *Placodermata* (Wall-case 4) are characteristic of the Old Red Sandstone or Devonian rocks. The head and anterior portion of the body were covered with large bony plates, sculptured and ornamented with beads of enamel.

In the genus *Pterichthys* (Figs. 26 and 27) there are two peculiar arms, or anterior fins, articulated to the sides of the body, just behind the head; the tail is covered with scales, and supports the dorsal fin.

Fig. 26.

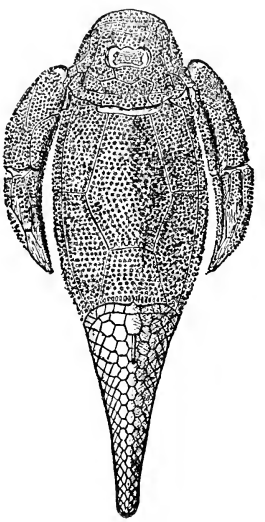

Fig. 27.

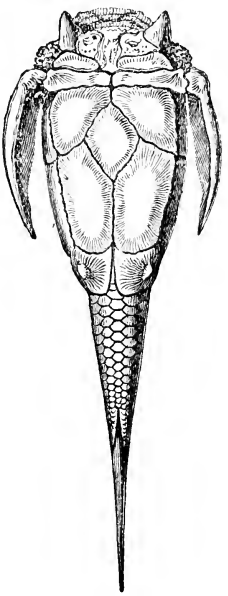

Fig. 26.—Dorsal surface of *Pterichthys Milleri* (after Pander), Old Red Sandstone, Scotland.
Fig. 27.—*Pterichthys cornutus*, Agassiz, Old Red Sandstone, Scotland.

The gigantic *Asterolepis* seems to have been allied to *Pterichthys*.

In *Coccosteus* (Figs. 28 and 29) the tail was destitute of scales, but very distinct neural and hæmal spines are seen with interspinous

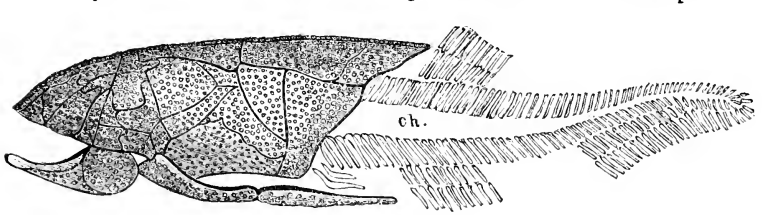

Fig. 28.—*Coccosteus* (after Pander), side-view, Old Red Sandstone. *ch* Position of the *chorda dorsalis*, or notochord.

bones, supporting a dorsal and anal fin, but no vertebræ have been observed, so that the notochord must have been persistent.

Prof. Newberry has described a huge Placoderm (*Dinichthys*)

from the Devonian of N. America, the dentition of which greatly resembles that of the recent *Protopterus* (Fig. 35); Dr. Traquair is of opinion that the Placodermata may turn out to have been an aberrant group of *loricated Dipnoi*.

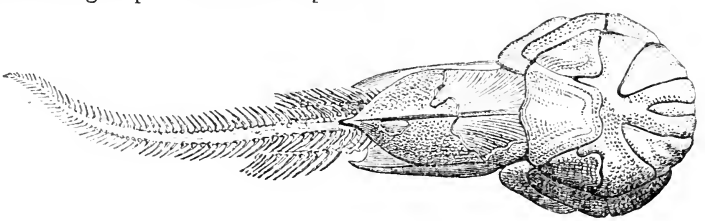

Fig. 29.—*Coccosteus decipiens* (dorsal aspect), Agassiz.

The *Cephalaspidæ* (Table-case 35) includes a peculiar and very ancient group of Palæozoic fishes, limited to the Upper Silurian and Old Red Sandstone.

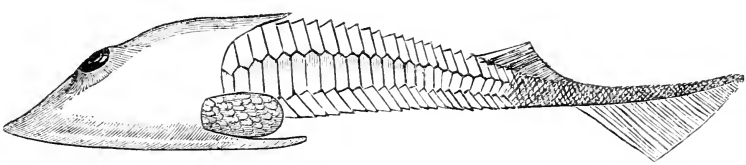

Fig. 30.—*Cephalaspis Lyelli* (restored), side-view (after Lankester), Old Red Sandstone, Forfarshire (drawn about one-third natural size).

The earliest (*Scaphaspis ludensis*) is from the Lower Ludlow rock, near Ludlow, the oldest known fish. The head is covered with a large buckler composed of one or more pieces, a tail covered

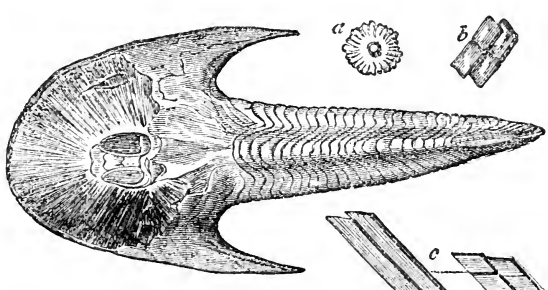

Fig. 31.—*Cephalaspis Lyelli* (dorsal aspect), from the Old Red Sandstone, Glammis, Forfarshire (about one-third the size of the original specimen). *a*, One of the peculiar ornaments (drawn natural size) with which the head is covered when the surface of the headshield is preserved; *b* and *c*, scales from different parts of the body and tail.

with rhombic scales; but no internal skeleton of any kind has been met with.

They are divided into two groups; *Heterostraci*, which have no bone-cells in their shields, viz.:—*Scaphaspis*, *Pteraspis*, and *Cyathaspis*: and *Osteostraci*, viz.:—*Cephalaspis*, *Auchenaspis*, and *Eukeraspis*, in which bone-cells are present.

Cephalaspis Lyelli, from the Old Red of Forfar, is one of the most perfect of these older fish. (*See* Figs. 30 and 31.)

Sub-order III.—Dipnoi.

The *Dipnoi* (Table-case 36, and portion of Wall-case 5), form a very peculiar sub-order, having three living representatives, namely, *Protopterus*, in Africa (Fig. 35), *Lepidosiren*, in South America, and *Ceratodus*, in Australia (Fig. 32).

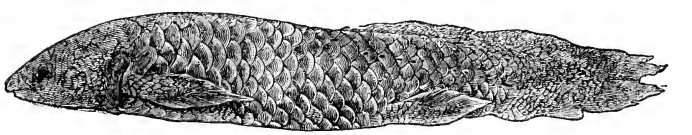

Fig. 32.—"The Australian Mudfish," *Ceratodus Forsteri* (recent), Australia.

In these fishes the skeleton is notochordal, there are a pair of pterygo-palatine teeth, and a pair of incisor-like vomerine teeth above, and a third pair of teeth in the lower jaw. There are two pairs of nostrils, more or less within the mouth, and the air-bladder, single or double, takes on the function of a lung. There is one external branchial aperture into which the gills project freely, as in Ganoids and Teleosteans.

The caudal fin is diphycercal or heterocercal, the scales are

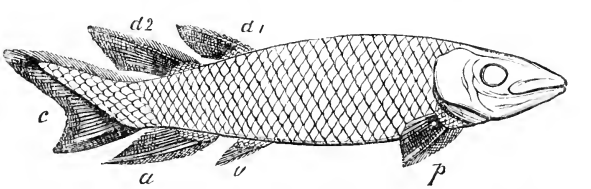

Fig. 33.—*Dipterus macrolepidotus*, Sedgw. and Murch., Old Red Sandstone, Scotland. *p*, Pectoral; *v*, ventral; *a*, anal; *d*1, anterior dorsal; *d*2, posterior dorsal; *c*, caudal fin.

cycloidal; the paired fins are acutely-lobate, with a central jointed cartilaginous stem fringed with radial cartilages and dermal fin-rays.

Dipterus, from the Devonian rocks, has two dorsal fins, a heterocercal tail and one anal fin. The head is covered with bony ganoid plates, and the scales are also ganoid. (*See* Fig. 33.)

Ctenodus, a common Carboniferous form, has bony head-plates

like those of *Dipterus*, but the scales are thin and the tail probably diphycercal. Teeth indistinguishable in character from the modern *Ceratodus* are abundant in the Trias and Rhætic. The other genera are *Palædaphus*, *Heliodus*, *Phaneropleuron* (Wall-case 5 A), from the Old Red Sandstone, and *Uronemus*, *Ganopristodus*, from the Carboniferous rocks.

[Ganoidei, proper.*]

The fishes of this order are, in most instances, covered with osseous ganoid scales or scutes—the ventral fins are always abdominal.

The skeleton in some is notochordal, or cartilaginous, in others partially or completely ossified.

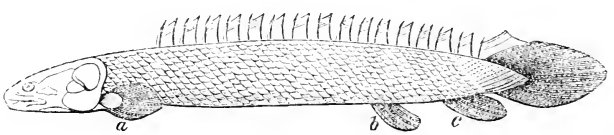

Fig. 34.—*Polypterus bichir*, living in the Nile, Gambia, &c. *a*, Pectoral fin; *b*, ventral; *c*, anal fin.

Only one external gill-opening exists on each side, protected by a gill-cover.

Among living Ganoids there are four well-marked types:—

Sub-order IV.—Crossopterygidæ.

The *Crossopterygidæ*, which are represented by *Polypterus* (Fig. 34) and *Calamoichthys*, are confined to the rivers of tropical Africa (especially those of the West coast) and the Upper Nile.

Sub-order V.—Acipenseroidei.

The *Acipenseroidei* are represented by *Acipenser*,† the Sturgeons, of which there are twenty species which frequent European, Asiatic, and American rivers. The skeleton in these fishes is notochordal; the skull is cartilaginous, with dermal ossifications and scutes.

* The three previously-noticed sub-orders—*Acanthodini*, *Placodermata*, and *Dipnoi*—are doubtfully classed under the Ganoidei: from the remarks of Prof. Huxley, Dr. R. H. Traquair, and others, it seems quite probable that these ancient types of fishes may hereafter form more than one distinct order.

† To this family also belong *Scaphirhynchus*, *Polyodon*, and *Psephurus*, found in the rivers of Asia and North America.

Sub-order VI.—Lepidosteoidei.

The *Lepidosteoidei* are represented by the *Lepidosteus*, the "Gar-pike," or "Bony-pike" of the rivers of North and Central America and Cuba: three species are living, having a completely ossified skeleton, the body being covered with stout rhombic ganoid scales.

Sub-order VII.—Amioidei.

The *Amioidei* are represented by the *Amia*, or "Bow-fin," of the United States fresh-waters.

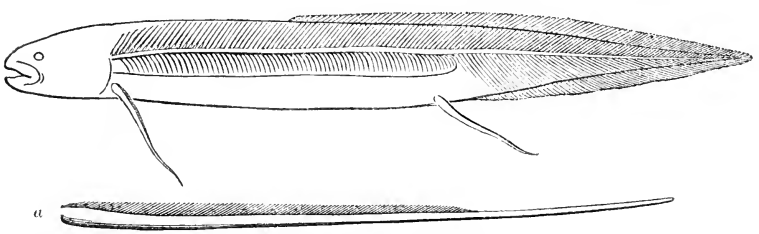

Fig. 35.—The African Mudfish, *Protopterus annectens*, living in the rivers of Africa. *a*, Represents one of the pectoral fins enlarged.

1. There is a long series of fossil forms from the Old Red Sandstone, and in later deposits, referred by Prof. Huxley to the *Crossopterygidæ*—the first are known as the *Holoptychiidæ*—having large rounded bony scales deeply imbricating and sculptured on

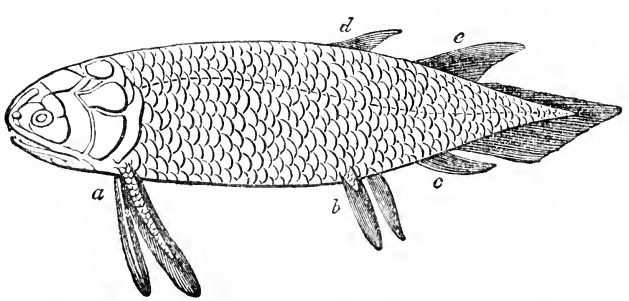

Fig. 36.—*Holoptychius*, Old Red Sandstone, Fifeshire (after Huxley). *a*, Paired pectoral fins; *b*, ventral fins; *c*, the anal fin; *d*, anterior dorsal; *e*, posterior dorsal fin.

their exposed surfaces. The skeleton is not known; most probably it was notochordal. They only occur in the Old Red Sandstone, and are represented by the genera *Glyptolepis* and *Holoptychius* (Fig. 36), from the Old Red Sandstone. (*See* Wall-case 5.)

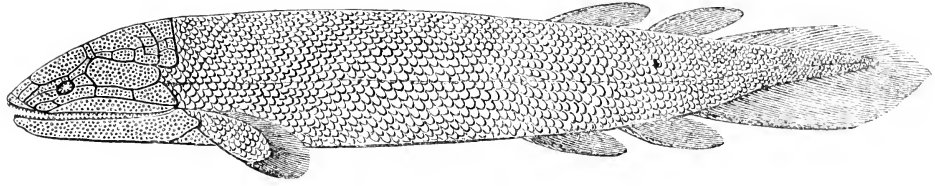

FIG. 38.—*Gyroptychius*, Old Red Sandstone, Scotland.

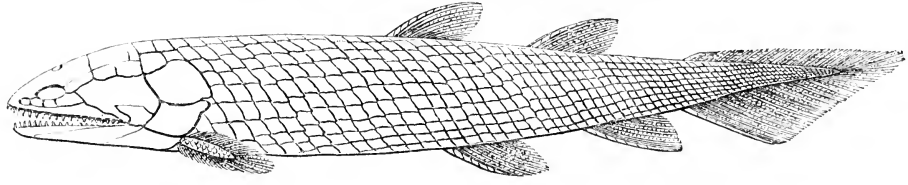

FIG. 39.—*Osteolepis* (restored outline after Pander), Old Red Sandstone, Scotland.

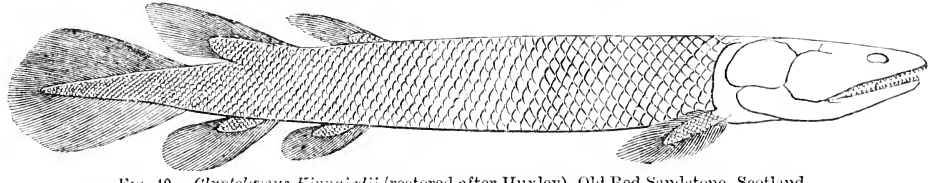

FIG. 40.—*Glyptolæmus Kinnairdii* (restored after Huxley), Old Red Sandstone, Scotland.

FIGS. 38–40 admirably illustrate the passage from the true diphycercal tail in Fig. 40, to the heterocercal in Fig. 39.

These are followed by the *Rhizodontidæ*, represented by *Tristichopterus* and *Gyroptychius* (Fig. 38), from the Old Red Sandstone, and *Rhizodus*, from the Lower Carboniferous of Scotland: to these succeed the *Saurodipteridæ*, represented by *Osteolepis* (Fig. 39) and *Diplopterus*, from the Old Red Sandstone; and *Megalichthys*, from the Coal-measures.

Fig. 37.—Tooth of *Strepsodus*.

Strikingly remarkable in this case (Wall-case 6) are the remains of *Rhizodus Hibberti*, from Burdie House, the huge teeth and detached bones of the head of which led the earlier observers to refer it to the Labyrinthodonts; *Rhizodus* was probably the largest of Palæozoic fishes.

Lastly, the *Cœlacanthidæ* (Wall-case 7), remarkable, as a family of fishes, for their long range in geological time, *Cœlacanthus* occurring in the Coal-measures, the Permian and the Upper Oolite; *Gyrosteus* in the Lias, *Undina* in the Oolites (Fig. 41), and *Macropoma* in the Chalk formation (Fig. 42). The walls of the air-bladder appear to have been ossified in these fishes, as is well seen in several specimens of the series of *Macropoma*.

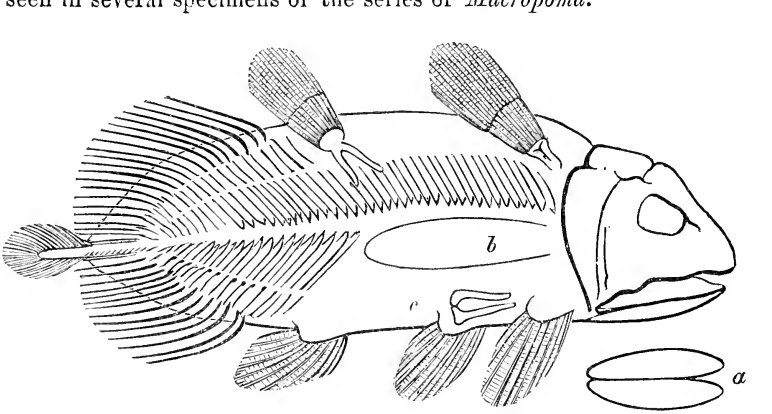

Fig. 41.—*Undina Kohleri*, Lias (restored outline after Huxley). *a*, Jugular plates; *b*, the ossified air-bladder; *c*, the pelvic bones.

2. The fossil representatives of the *Acipenseroidei* are as follows: The *Chondrosteidæ*, with a single genus, *Chondrosteus*, in the Lias (Wall-case 7).

Bony plates of Acipenser occur in the London Clay of Sheppey (Wall-case 7) and in the Suffolk Crag.

The *Palæoniscidæ* (Wall-case 8, and Table-cases 37, 38, 39), in which the body is covered with rhombic, ganoid, and often beautifully sculptured scales, the caudal fin being completely heterocercal and Sturgeon-like.

One genus, *Cheirolepis* (Wall-case 8A), remarkable for its very minute scales, is known, from the Old Red Sandstone. The family attained its maximum in the Carboniferous formation, being re-

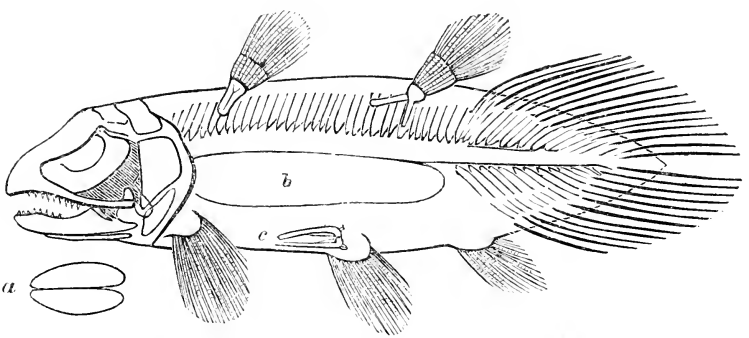

FIG. 42.—*Macropoma*, Chalk, Lewes (restored outline after Huxley). *a*, Jugular plates; *b*, the ossified air-bladder; *c*, the pelvic bones.

presented by *Elonichthys*, *Rhadinichthys*, *Nematoptychius* and *Gonatodus*.

To these several new genera have been recently added from the Lower Carboniferous of Eskdale, Dumfriesshire (*see* Table-case 39).

Palæoniscidæ are also abundant in the Permian rocks both of England and the Continent (Fig. 47).

In the Magnesian Limestone of Durham we have *Pygopterus*, *Acrolepis*, and *Palæoniscus*, these also occur in the Kupferschiefer of Germany, and in the unteres-Roth-liegendes occur *Amblypterus* (Fig. 43) and *Rhabdolepis*. In Fig. 43 are given views (*a*) of four of the scales, showing the outer surface, and (*b*) of two of the scales, showing the inner surface. Each of the rhomboidal ganoid scales of *Amblypterus* has a ridge on the inner surface which is produced at one end into a projecting peg which fits into a notch in the next scale, reminding one of the manner in which tiles are pegged together on the roof of a house. The Triassic scales known as *Gyrolepis*, and the teeth named *Saurichthys*, probably both belong to a Palæoniscid fish (Traquair). In the English Lias are found *Oxygnathus*, *Cosmolepis*, and *Thrissonotus*. The *Palæoniscidæ* do not extend upwards beyond the Lias.

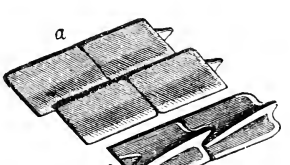

FIG. 43.—Ganoid scales of *Amblypterus striatus*, Carbonifs.

The *Platysomidæ* (Wall-case 8B, and Table-case 39) are most nearly related to the *Palæoniscidæ*. They are confined to the Carboniferous and Permian formations.

Platysomus (Fig. 44), *Eurynotus* (Fig. 45), *Wardichthys*, *Cheirodus* (*Amphicentrum*) (Fig. 46), *Mesolepis*, *Benedenius*, *Eurysomus*, are placed here, and perhaps also *Dorypterus*.

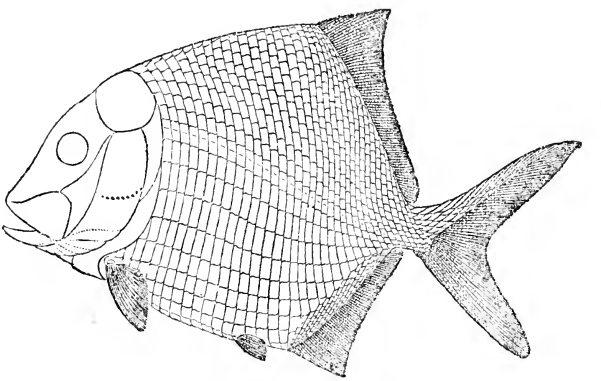

FIG. 44.—*Platysomus striatus*, Agassiz (restoration after Dr. R. H. Traquair), Magnesian Limestone.

3. The *Lepidosteoidei*, illustrated by the recent *Lepidosteus*, or bony pike of North America, were abundantly represented in Mesozoic times by a large series of fishes; embracing the *Sauriдæ*, the *Sphærodontidæ*, the *Dapediidæ* (or *Stylodontidæ*), the *Aspi-*

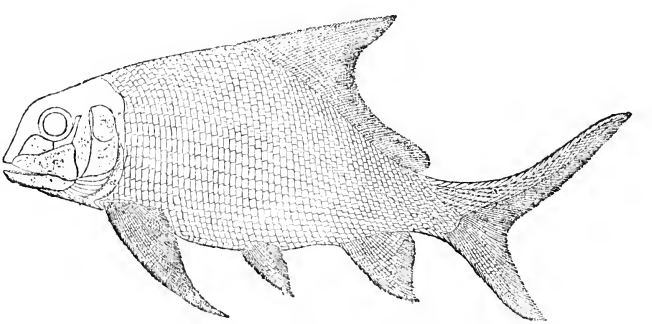

FIG. 45.—*Eurynotus crenatus*, Agassiz, "Cement-stones," Carboniferous Series of Scotland (after Traquair).

dorhynchidæ, and the *Pycnodontidæ* (Fig. 48); having rhombic ganoid scales and semi-heterocercal tails; the vertebræ were less ossified than in the recent *Lepidosteus*, and in all the notochord was more or less persistent. In the *Pycnodontidæ* the mouth was

provided either with conical or flattened teeth arranged in longitudinal rows, or with formidable pointed teeth, and large and small premaxillary teeth. (*See* Table-cases 44, 45.)

The dorsal and anal fins were long and opposite one another; the caudal fin equilobate externally, but the notochord very distinctly upturned at its termination.

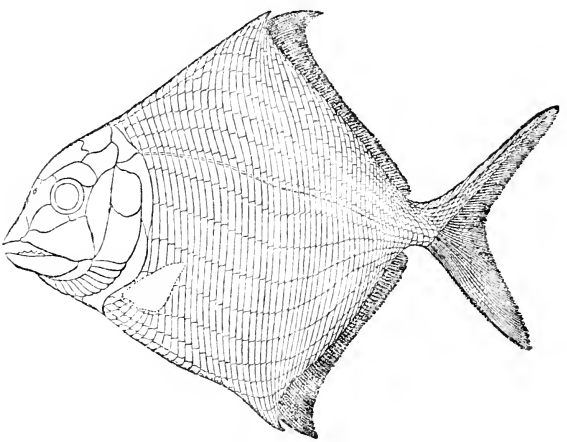

FIG. 46. – *Cheirodus granulosus*, Young (restoration after Traquair), Coal-measures.

The Lepidosteoid fishes have a range in time from the Lias to the present day. Among the genera represented are *Lepidotus*, *Dapedius*, *Tetragonolepis*, *Heterolepidotus*, *Pholidophorus*, *Pachycormus*, *Semionotus*, *Aspidorhynchus*, etc. (*See* Wall-cases 9, 10, 11, 12, 13 and 14; and Table-cases 40, 41, 42, 43, 44, 45.)

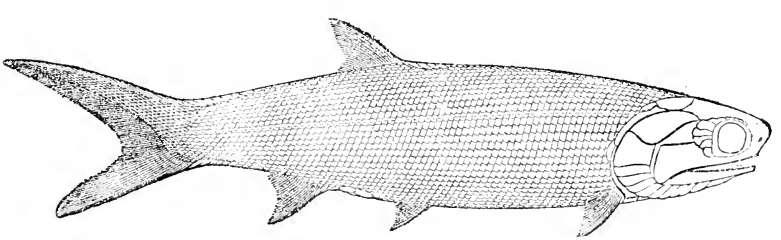

FIG. 47.—*Palæoniscus macropomus*, Ag. (from a restoration by Dr. R. H. Traquair), Kupferschiefer.

One of the largest of these is *Lepidotus maximus* (Wall-case 10), from the Lithographic Stone of Solenhofen, in Bavaria, which measures 5 feet 7 inches in length, and is 2 feet in greatest depth.

4. The *Amioidei*.

In Wall-case 15, and Table-cases 45, 46, and 47, are arranged the

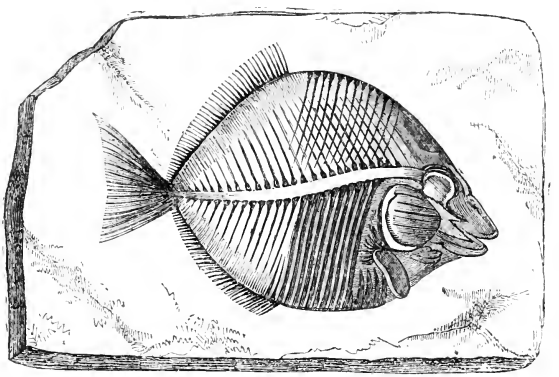

FIG. 48.—*Stemmatodus* (*Pycnodus*) *rhombus*, Oolite.

fossil fish referred to the *Amiodei*, *Leptolepis* (Fig. 50), *Thrissops*, *Megalurus*, *Oligopleurus*, from strata of Jurassic age.

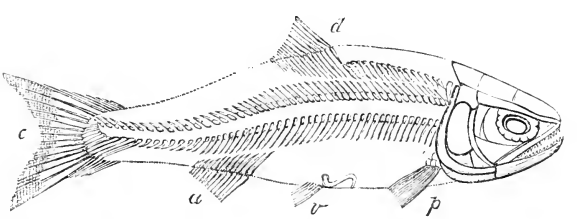

FIG. 49.—*Caturus furcatus*, Lithographic Stone, Upper white Jura, Solenhofen. *p*, Pectoral fins; *v*, ventral fins; *a*, the anal fin; *d*, dorsal fin; *c*, caudal fin. Just above *v* are seen the pelvic bones.

Protamia and *Hypamia*, from the Tertiary deposits of North America, are clearly allied to *Amia*.

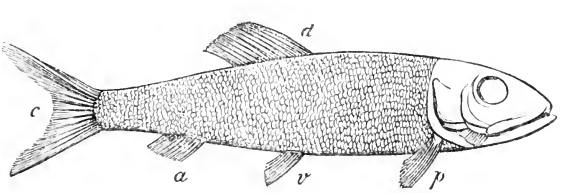

FIG. 50.—*Leptolepis sprattiformis*, Lithographic Stone, Solenhofen. *p*, Pectoral fins; *v*, ventral fins; *a*, anal fin; *d*, dorsal fin; *c*, caudal or tail-fin.

SUB-CLASS IV. TELEOSTEI.*

(*See* Table-cases 48–56, and Wall-cases 16–18.)

The fishes belonging to this division have a well-ossified skeleton and biconcave vertebræ; the tail is homocercal (although in very early stages of its development it has a heterocercal form, as in the previous groups); they are usually protected externally by thin imbricating, ctenoid or cycloid scales (see Fig. 53), sometimes by bony plates; in some the skin is naked. The gills are free, with one external opening protected by a gill-case.

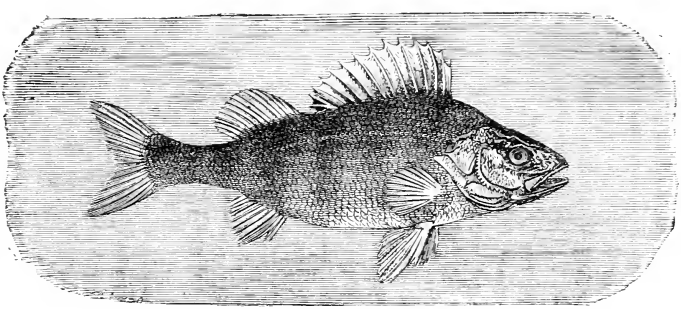

FIG. 51.—The Freshwater Perch (*Perca fluviatilis*), living in the inland freshwaters of Europe and Asia.

The Teleosteans, as at present defined, make their first appearance in the Cretaceous period, and are divided into the following groups:—

The ACANTHOPTERYGII; characterized by having a greater or lesser number (varying according to the species) of the anterior rays of the dorsal and ventral fins projecting as acutely-pointed

* In reference to the Teleostean fishes it is necessary to remark that no very complete or satisfactory classification of this group at present exists. It has, therefore, been considered most convenient to follow, as far as possible, the only published English classification of these fishes, namely, that given by Dr. Günther. But as there are a great many fossil genera and species altogether omitted by that Ichthyologist from his catalogue, these have been grouped according to their probable affinities, or as originally placed by Agassiz. A more careful revision of this great Division is absolutely needful before the fossil forms can be arranged in their natural relation to existing fishes. Dr. R. H. Traquair, who has devoted some time to the study of this class, has, unfortunately, not yet published his views thereon. The writer takes this opportunity to acknowledge his indebtedness to his colleague, Dr. A. Günther, F.R.S., from whose work, entitled "Introduction to the Study of Fishes," he has made numerous extracts, especially in reference to the Teleostei.

inflexible spines (Fig. 52, *k*), the other rays of the fins being more or less articulated and flexible; the ventral fins are thoracic, and the scales are usually ctenoid (Fig. 53, B).

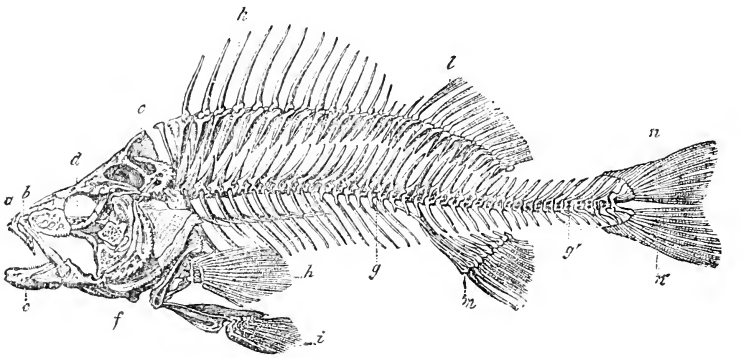

Fig. 52.—Skeleton of the Common Perch. *a*, Premaxillary bone; *b*, maxillary bone; *c*, lower jaw; *d*, palatine arch; *e*, cranium; *f*, interopercnlum; *g g'*, vertebral column; *h*, pectoral fin; *i*, ventral fin; *k*, spinose dorsal fin; *l*, soft dorsal fin; *m*, anal fin; *n*, upper, and *n'*, lower lobe of caudal fin.

[Theoretically the pair of pectoral fins are homologous with the anterior pair of limbs in the higher Vertebrata, whilst the pair of ventral fins correspond to the posterior pair of limbs. All the fins behind the ventral fins are merely accessory to the caudal fin, and, properly speaking, belong to the tail. None of the other fins save the pectorals and ventrals are paired.]

The following families are represented by fossil genera and species, namely:—

The *Percidæ* (to which family the well-known "Freshwater Perch," Figs. 51 and 52, belongs); these fishes are abundant in some of the Tertiary limestones, as in the Eocene of Monte Bolca, where species of *Labrax*, *Lates*, *Smerdis*, *Cyclopoma*, *Serranus*, and many other genera occur fossil. *Paraperca* has been met with at Aix, and a large species of *Perca* in the Miocene freshwater limestone of Œningen near Lake Constance.

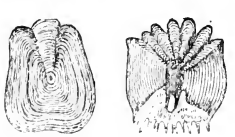

Fig. 53.—Scales of Teleostean Fishes. A, Cycloid;* B, ctenoid.†

The *Squamipinnes*—"Coral Fishes"—a group of fishes having the vertical fins (dorsal and anal) thickly covered with scales, and comprising the beautifully-coloured fishes of the genera *Chætodon*, *Heniochus* and *Holacanthus*, chiefly inhabitants of the Atlantic and Indo-Pacific areas. They have their fossil representatives in the Tertiary of Monte Bolca near Verona, but they are all referable to the existing genera, *Pomacanthus*, *Ephippium*, *Scatophagus*, and *Holacanthus*. The genus *Toxotes* is also found fossil at Monte Bolca.

* *Cycloid*, circular scales.

† *Ctenoid*, having the margin toothed (comb-like).

The *Sparidæ* ("Sea-Bream") have their fossil representatives in the Cretaceous of Mount Lebanon, which are placed in the genera *Sargus* and *Pagellus*.

The other fossil species occur in the Eocene and Miocene, namely, *Sparnodus*, *Sargodon*, *Capitodus*, *Soricidens* and *Asima*.

Teeth belonging to the living genus *Chrysophrys* have been found in the Miocene Tertiary of Malta and in the Red Crag of Suffolk.

[The *Scorpenidæ* resemble the "Sea-perches" both in form and habits, but some of them are bottom-dwellers and possess curious appendages resembling fronds of sea-weed, which serve to conceal them. They have one fossil representative, *Scorpæna*,* in the

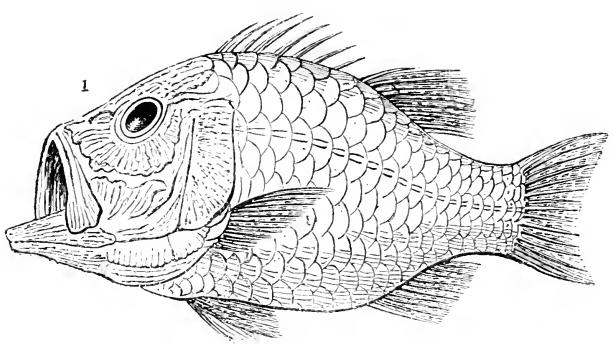

FIG. 54.—*Beryx Lewesiensis*, Mantell, Chalk, Sussex.

Eocene Tertiary Diatomaceous Earth (*polir-schiefer*) of Oran in Algeria.]

The *Berycidæ* are among the earliest of the Teleostean fishes; well-preserved specimens belonging to this family occur in the Greensand (Planerkalk) of Westphalia, and are very characteristic of the Chalk formation both in England and Mount Lebanon, Syria. They are represented by the genera *Beryx*, *Pseudoberyx*, *Berycopsis*, *Homonotus*, *Stenostoma*, *Sphenocephalus*, *Acanus*, *Acrogaster*, *Rhacolepis*, the two last-named from the Chalk of Brazil. The genera *Holocentrum* and *Myripristis* occur in the Eocene of Monte Bolca.

Of the genus *Beryx* (Fig. 54) a fine series is exhibited from the English Chalk (including the type-specimens figured by Agassiz from the late Dr. Mantell's collection); many of the specimens, being but slightly compressed, retain their original form.

In *Pseudoberyx* the ventral fins are abdominal, and *Berycopsis* has thin cycloid scales; in *Beryx* the scales are large, thick, and ctenoid (pectinated).

* There is no example of this in the collection.

The *Xiphiidæ* or "Sword-fishes," are pelagic fishes inhabiting the open seas; they attain a length of from 12 to 15 feet.

The upper jaw in these fishes is produced into a long cuneiform weapon; and the dorsal fin is enormously developed in the Flying Sword-fish, *Histiophorus*.

The Sword-fishes are an ancient type of fishes, *Tetrapterus* having been found in the Chalk of Lewes and Maestricht, and in the London Clay of Sheppey, with *Cœlorhynchus*.

The *Trichiuridæ*—"Scabbard-fishes," "Hair-tails,"—include those fishes with elongate compressed or band-like bodies; wide mouths armed with several strong teeth in the jaws or upon the palate; the dorsal fin is long and many-rayed; the caudal fin is forked.

There are two extinct genera known, namely, *Enchodus*, from the Gault of Folkestone, the Chalk of England, and of Maestricht in Holland; and *Anenchelum*, from the black (Eocene) slates of the Canton Glaris.

Another Eocene genus is *Xiphopterus;* whilst *Lepidopus*, *Hemithyrsites*, and *Trichiurichthys*, have been obtained in the Miocene deposits of Licata in Sicily.

The *Palæorhynchidæ* were slender compressed fishes, having the jaws prolonged into a sharp-pointed edentulous beak (like the bill of a heron or crane); the dorsal fin extends from the nape of the neck to the tail-fin, and the rays supporting it were not articulated. They are supposed to have been deep-sea fishes.

This family has no living representatives, and contains only two extinct genera, namely, *Palæorhynchus*, from the Eocene Tertiary of the Canton Glaris, and *Hemirhynchus*, from the Paris Basin.

The *Acronuridæ* ("Surgeons") are represented by two extinct species belonging to the genera *Acanthurus* and *Naseus*, found fossil in the Eocene of Monte Bolca.

Their living representatives at the present day are inhabitants of tropical seas, and frequent Coral-Reefs, where they feed upon vegetable substances, or upon the animal matter of the Coral.

The *Carangidæ* ("Horse-Mackerel," "Pilot-fish," "Boar-fish") appear first in the Cretaceous formation, being represented by the genera *Platax*, *Vomer*, and *Aipichthys*, from the Chalk of Comen in Istria (Trieste).

They occur more numerously in the various Tertiary formations, especially at Monte Bolca, where several still-existing genera occur, as *Zanclus*, *Platax*, *Caranx* (*Carangopsis*), *Argyriosus*, (*Vomer*), *Lichia*, and *Trachynotus*.

The extinct genera are *Amphistium*, *Ductor*, and *Semiophorus*, from Monte Bolca; *Archæus*, from the dark (Eocene) slates of Canton Glaris; *Pseudovomer* and *Equula*, from the Miocene marls of Licata in Sicily.

Semiophorus is characterized by the enormous development of the dorsal fin, which commences immediately above the head; the ventrals are long and slender, they are thoracic, and placed below

and in advance of the pectorals, which are very small. (*See* Wood-cut, Fig. 55.)

The *Cyttidæ*—fishes of the "Dory"* family—are represented by the genus *Zeus* in the Miocene Tertiary of Licata in Sicily.

The *Coryphænidæ*—(Dolphins, Sun-fish)—are known in a fossil

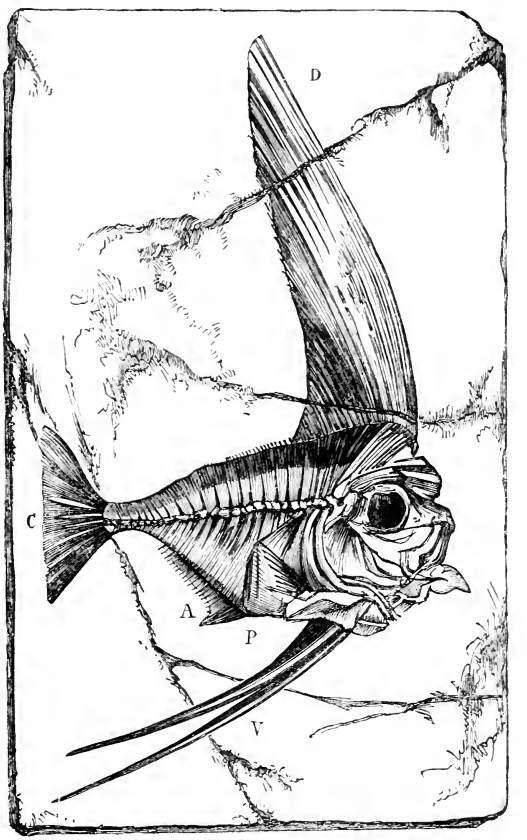

FIG. 55.—*Scmiophorus velicans*, Agassiz, from the Eocene-formation of Monte Bolca. A, Anal fin; C, caudal; D, dorsal; P, pectoral; V, ventral fins.

state by the genus *Goniognathus*, from the London Clay of the Isle of Sheppey, and by the curious "Thread-fin," *Gasteronemus*, from the Eocene Tertiary of Monte Bolca near Verona.

* Commonly called "John Dorys," being a corruption of the Gascon word "Jan," a cock, and the French word "dorée," gilded; hence the name means really "Gilt-Cock." (Günther.)

The *Scombridæ*—or Mackerel family*—occur fossil in various Tertiary deposits. Two extinct genera, *Palimphyes* and *Isurus*, have been found in the Eocene slates of the Canton Glaris, and *Scomber*, *Thynnus*, and *Cybium* are not uncommon in the Eocene and Miocene formations.

The *Trachinidæ*—("Stare-gazer," "Weever," &c.). To this family belongs the genus *Callipteryx*, from the Eocene Tertiary of Monte Bolca; it is a scaleless form of fish.

Trachinopsis has recently been described from the Tertiary beds of Lorca in Spain, and *Pseudoeleginus*, from the Miocene of Licata, in Sicily.

The *Cottidæ*—("Bull-heads," "Gurnards," &c.)—represented by the genus *Cottus*, or the "Miller's Thumb," occur fossil in the Miocene freshwater deposits of Œningen. The family also occurs at Aix in Provence.

The *Blenniidæ*—"Blennies"—are scarcely known in the fossil state, but *Pterygocephalus*, from the Eocene of Monte Bolca, appears to have been a Blennoid.

The *Sphyrænidæ* are a family of large fishes of voracious habits (called "Barracudas") met with along the coast of the West Indies and in other tropical seas. They are covered with small cycloid scales, the mouth is wide, and armed with strong teeth. The "Barracuda" attains a length often of eight feet.

The family is known in a fossil state by the genera *Hypsodon*, from the Chalk of Sussex, *Saurocephalus*, from the Upper Cretaceous of Maestricht, *Sphyrænodus* and *Hypsodon*, from the London Clay of Sheppey and from the Eocene of Monte Bolca near Verona.

The *Saurodontidæ*, a family nearly allied to the preceding one, was established by Prof. Cope for the reception of a group of predaceous fishes from the Cretaceous formation of N. America; many of them are of large size and have most of the teeth implanted in distinct sockets (alveoli); it comprises the genera *Portheus*, *Ichthyodectes*, and *Daptinus*. Species of these genera also occur in British Cretaceous deposits.

Erisichthe is an allied genus, but is now referred by Cope to a distinct family (the *Erisichthidæ*). *Erisichthe* is remarkable for having the ethmoid bone prolonged beyond the maxillæ and consolidated into a cylindrical rostrum, forming a formidable weapon of offence.

The anterior teeth—erroneously referred by Agassiz to *Saurocephalus*—are large and lanceolate in form, and implanted in sockets as in the *Sphyrænidæ*.

The teeth, and also the rostral bones, are found in all the British Cretaceous strata.

* Includes, besides the Mackerel, the "Tunny," the "Bonito," the "Albacore," and the "Sucking-fish."

The *Atherinidæ* are represented at Monte Bolca by two very small species of *Atherina* and by the genus *Mesogaster*.

Mugilidæ—"Grey Mullets."—Remains of the genus *Mugil* have been found in the Tertiary deposits of Aix in Provence.

The *Fistulariidæ*—"Flute-mouths"—are well represented in the Eocene formation. Fossil remains of the two living genera, *Fistularia* and *Aulostoma*, occur at Monte Bolca and in the slates of the Canton Glaris.

Auliscops, another existing form, has been found fossil at Padang, in the Tertiary Lignites of the Island of Sumatra.

Two extinct genera occur at Monte Bolca, *Urosphen*, the cylindrical body of which is terminated by a large cuneiform fin; and *Rhamphosus*, which has an immense spinous ray, denticulated behind, inserted on the nape.

The *Centriscidæ*—"Bellows-fish"—occur fossil in the Eocene Tertiary strata of Monte Bolca, whence the genus *Amphisile* is recorded.

The PHARYNGOGNATHI have the lower pharyngeal bones united and dentigerous.

Labridæ—the "Wrasses"—have been found fossil in the Tertiary formations of France, Germany, Italy and England, and have been recognized by their united pharyngeal bones, which bear molar-like teeth.

The genus *Labrus* occurs at Monte Bolca, and in the Swiss Molasse. *Nummopalatus* and *Phyllodus* are allied forms, but cannot be assigned to any recent genus; the latter first occurs in the Cretaceous of Germany, and is not uncommon in the London Clay of Sheppey, and by derivation in the Suffolk Crag.

The Collection now contains nearly the whole of the British specimens of *Phyllodus* and *Egertonia* figured in Prof. Cocchi's Monograph on these fishes.*

Taurinichthys occurs in the Miocene of France; it represents the living *Odacina*; the genus *Odonteus* is found fossil at Monte Bolca, whilst *Egertonia*, from the London Clay of Sheppey, differs in the form of its palatal-like teeth from all recent genera of *Labridæ*.

The ANACANTHINI are a group of fishes in which the fins are without spinous rays: there is no air-duct; the ventral fins are jugular or thoracic.

The *Gadidæ*—"Cod-fishes"†— so abundant in the living state, are rarely met with fossil. Two genera, *Nemopteryx* and *Palæogadus*, occur in the black slates of Glaris; other forms occur allied to *Gadus*, *Merluccius*, and *Phycis*, in the London Clay of Sheppey, and in the Miocene deposits of Licata in Sicily.

The *Pleuronectidæ*—"Flounders."—The "Flat-fishes" are characterized, except in the very young state, by the peculiar habit of constantly swimming and resting upon one side, the forepart of

* "Monografia dei Pharyngodopilidæ," Florence, 1864.

† This family also includes the "Hake," "Burbot," "Ling," "Rockling," "Torsk," &c.

the head, with both eyes, becoming gradually twisted to the upper or opposite side.

"Flat-fishes" were not abundant in Tertiary times; the only representatives being the genus *Rhombus*, from the Eocene of Monte Bolca, and a small "Sole" (*Solea*) from the Miocene near Ulm in Würtemberg.

Physostomi.—The fishes of this division have all the fin-rays articulated, only the first fin-ray of the dorsal and pectoral fins being sometimes ossified. The ventral fins (if present) are abdominal and without a spine.

The *Siluridæ*—"Cat-fishes."—A group of freshwater fishes without scales, but in some genera the head and body are more or less protected by dermal osseous scutes.

The fossil representatives are *Coccodus*, from the Upper Chalk of the Lebanon; *Silurus*, from the Middle Eocene of Bracklesham, and from some localities in France. Remains of undescribed species from the Siwalik Hills, India, and from the highlands of Padang, Sumatra, where the genera *Pseudeutropius* and *Bagarius*, belonging to types common to India, have been found. Spines referable to "Cat-fishes" occur also in the Tertiary deposits of North America.

The *Scopelidæ* are exclusively marine pelagic or deep-sea fishes. They are represented by *Hemisaurida* (allied to *Saurus*), from the Chalk of Comen in Istria; *Parascopelus* and *Anapterus*, from the Miocene of Licata in Sicily.

The *Cyprinidæ*—the Carps, Goldfish, Tenches and Minnows—belong to this family. Most of the fossil forms are referable to existing genera. They occur in the Miocene Freshwater Limestone of Œningen, and Steinheim; in the lignites of Bonn, Stöchen, Bilin and Ménat, also in the marl-slates of Licata in Sicily; at Idaho in North America, and Padang in Sumatra.

The genera represented are:—*Barbus*, *Thynnichthys*, *Gobio*, *Leuciscus*, *Tinca*, *Amblypharyngodon*, *Rhodeus*, *Cobitis*, *Acanthopsis*, *Cyclurus*, *Hexapsephus*, and *Mylocyprinus*. Only a few exhibit any characters by which they can be distinguished from living forms.

The *Cyprinodontidæ* are a family of very small freshwater fishes, most of the fossil species of which may be referred (in the opinion of Dr. Günther) to the living genus *Cyprinodon*. *Lebias* is found in the Upper Eocene deposits of Aix in Provence; in the Miocene Limestone of Œningen; the Brown Coal of Bonn, and in the Marl of Gesso and St. Angelo. *Pœcilia* also occurs at Œningen.

The remains of one species of *Lebias* (*L. cephalotes*) are found in shoals covering the surface of slabs of slaty marl at Aix in Provence; several good specimens of this may be seen in the Cases.

The *Scombresocidæ* are a family composed chiefly of marine fishes, some living in the open ocean, whilst others have become acclimatized in freshwater; the latter are viviparous, the former are

all oviparous. The "Flying-fish"—*Exocetus* (Fig. 56)—and the "Saury" and "Gar-pike" belong to this family. The genus *Holosteus* occurs fossil in the Eocene of Monte Bolca, and *Belone* (the "Gar-pike") in the Miocene of Licata in Sicily.

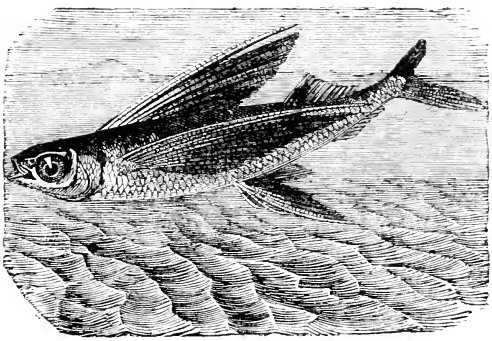

Fig. 56.—The Flying Fish (*Exocetus volitans*), living in the Mediterranean Sea.

The *Esocidæ*.—Fishes of this family, apparently identical with the existing freshwater "Pike" (Fig. 57), are abundant in the Miocene Limestone of Œningen, and in the freshwater Marl of Silesia. Very perfect specimens of *Esox*, from the first-named locality, are exhibited in the Wall-cases. An allied genus is *Sphenolepis*, a large fish with long wedge-shaped scales; it occurs in the freshwater limestone at Aix, and in the Gypsum at Paris.

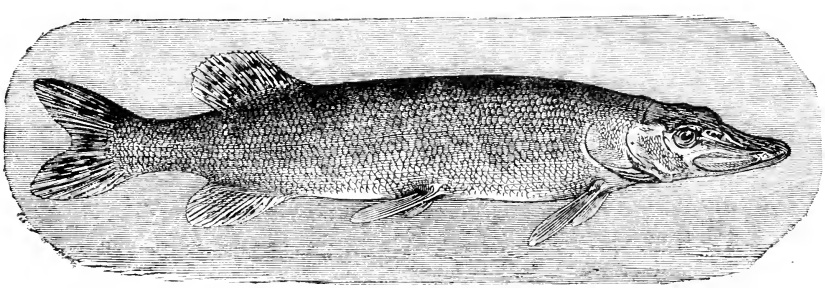

Fig. 57.—The Common Pike (*Esox lucius*), living in the freshwaters of Europe, &c.

The *Salmonidæ*—or Salmon-family—which inhabit both the sea and freshwater, are peculiar to the temperate and Arctic zones of the Northern hemisphere: only one occurring in New Zealand. This is one of the most valuable families of fishes to man. None

of the exclusively freshwater forms have at present been met with in a fossil state.

The genus *Osmerus*, commonly known as the "Smelt" (*Osmerus eperlanus*), is met with in considerable numbers in many localities along the coasts of Northern Europe and America. It ascends the tideway of rivers for the purpose of spawning. In the sea it attains a length of eight inches; but it frequently migrates from the sea into rivers and lakes, where its growth is very much retarded.

That this habit is one of very old date is proved from the fact that this small freshwater form occurs and is fully acclimatized in lakes which have now no open communication with the sea. And still more remarkable, this same migratory habit, with the same result, has been observed in the Smelt of New Zealand (*Retropinna Richardsoni*).

Osmerus also occurs fossil in the Greensand of Ibbenburen, in the Eocene slates of Glaris and the Miocene of Licata.

The genus *Osmeroides*, of which there is a fine series in the collection, consists of fishes closely allied to the "Smelts." Their remains are not uncommon in the English Chalk, in reference to which we may here remark that many of the Chalk Ichthyolites occur uncompressed, the result of calcareous particles replacing the muscular and other tissues as rapidly as they were destroyed by decomposition, and thus preventing the collapse of the flanks, and preserving the natural rotundity and form of the fish when living. Many illustrative examples may be seen in the cases; and notably a specimen of this genus that has frequently been figured, and which Dr. Mantell, who extracted it from the chalk, thus describes:—"This matchless ichthyolite is nine inches long, and the chalk has been cleared away so as to expose the entire body, lying six inches in relief above the block, to which it is attached by the dorsal aspect. The mouth of the fish is open, the opercula or gill covers, and the branchial arches are expanded; the pectoral and ventral fins, and the dorsal fin, are in their natural position."*

Acrognathus is an extremely rare fish, and *Aulolepis* (Pipe-scale) is far from being common. It derives its name from the peculiar form of the tube in the scales of the lateral line. This line is present in some form in all the osseous fishes, both fossil and recent, and consists of a successional series of perforated scales, extending from the head to the tail on each side; their function being the excretion of a lubricating mucus, which enables the fish to move rapidly through the water without friction.

The genera *Osmeroides*, *Acrognathus*, and *Aulolepis* have been found fossil in the Chalk of Lewes.

The "Capelin," *Mallotus villosus*, is found in great abundance on the Arctic coasts of America and Kamtschatka. It is caught in immense numbers by the natives, who consume it fresh, and also

* "Petrifactions and their Teachings" (p. 449), by G. A. Mantell, M.D., F.R.S., &c.

dry it, as a staple article of food for winter use. Its length does not exceed nine inches. It is frequently met with in a fossil state enclosed in concretionary nodules, of Newer Tertiary age, on the coast of Greenland and in Pliocene (?) drift on the banks of the Ottawa River, in Lower Canada.

The *Clupeidæ*—"Herrings" (Fig. 58)—so abundant in the seas around our coasts at the present day, are first met with in the Gault of Folkestone, represented by the genus *Thrissopater*. *Halec* is found in the Chalk of Bohemia; *Leptosomus*, *Opisthopteryx*, *Spaniodon*, *Rhinellus*, *Scombroclupea* and *Clupea* in the Upper Cretaceous of the Lebanon; *Clupea* also occurs fossil at Monte Bolca; at Glaris, and in the Miocene of Ulm in Würtemberg; whilst *Spathodactylus*, *Crossognathus*, *Platinx*, *Cœlogaster*, *Engraulis*, and *Chanos* are found in the slates of Glaris; at Monte Bolca and at

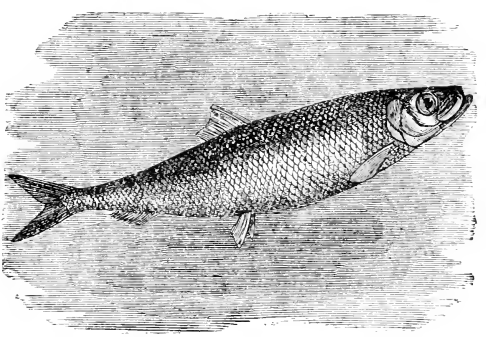

Fig. 58.—The Common Herring (*Clupea harengus*), living in the North Atlantic.

Licata in Sicily. *Hemitrichas* occurs in the Tertiary of Northern Italy, and *Alosa* in the Infusorial Earth of Oran in Algeria.

There are many species of the Herring (*Clupea*) met with in the Lebanon Cretaceous rocks, but they are all small fishes, the largest being about the size of our common Sprat.

Owing to some physical change in the conditions of the sea at the time these deposits were being laid down, these fishes appear sometimes to have been suddenly overwhelmed by fine calcareous mud and to have perished in shoals. This is well shown by several slabs of a fissile Limestone from Hakel near Beyrout (exhibited in the cases), which are covered with hundreds of their remains.

The *Bathythrissidæ* are perhaps represented in the Eocene formation by the genus *Notæus* from the gypsum quarries of Montmartre.

The *Chirocentridæ* are found fossil in the Chalk of Comen in Istria and in the Lebanon where the genus *Chirocentrites* occurs. Remains of a fish, allied to *Chirocentrus*, have been met with fossil in the Tertiary lignites of Padang in Sumatra.

The *Notopteridæ*.—Well-preserved remains of the genus *Notopterus* occur also in the Miocene Tertiary beds of Padang, Sumatra.

The *Hoplopleuridæ* are a family of extinct fishes devoid of true scales, but having the back and sides partially protected by symmetrical scutes arranged in series, and in some species by intermediate smaller ones.

Plinthophorus and *Dercetis* occur in the Chalk of England; and *Dercetis*, *Leptotrachelus*, and *Eurypholis*, are abundant in the Chalk of the Lebanon, from which locality a fine series in almost perfect preservation may be seen in the Cases. The genera *Pelargorhynchus* and *Ischyrocephalus* are from the Cretaceous of Westphalia, and *Saurorhamphus* from the Chalk of Comen, Istria.

The *Muræniдæ* (the "Eels" and "Conger Eels") are spread over almost all freshwaters and seas of the temperate and tropical zones; some even descend to the greatest depths of the ocean.

They are represented in the London Clay at Sheppey; by the genus *Rhynchorhinus;* by *Anguilla*, *Sphagebranchus*, and *Ophichthys* (*Ophisurus*), in the Eocene of Monte Bolca and of Aix; and in the Miocene freshwater deposits of Œningen.

The Lophobranchii have the gills arranged as small rounded lobes, or tufts, attached to the branchial arches; the gill-cover is reduced to a large single plate. To this division belong the Pipe-fishes, and the *Hippocampus* ("sea-horses").

The *Solenostomidæ* are known by a single living genus, *Solenostoma*, preceded in Tertiary times by *Solenorhynchus* from Monte Postale.

The *Syngnathidæ*—"Pipe-fishes"—fossil species of *Siphonostoma* and *Syngnathus*, also remains of an extinct genus, *Calamostoma*, allied to the living *Hippocampus*, have been found in the Eocene strata of Monte Bolca, and in the Miocene of Licata in Sicily.

Plectognathi.—In this division the skeleton is incompletely ossified; the gills are pectinate, the gill-opening narrow, the mouth small; the bones of the upper jaw are generally firmly united. The ventral fins are absent or reduced to spines.

The *Sclerodermi* are tropical and sub-tropical fishes living on Corals and Molluscs, on which they are enabled to feed by means of their chisel-like teeth; with these they break pieces off the former and bore holes in the shells of the latter.

Ostracion is found in the Eocene of Monte Bolca, and the dark slates of the Canton Glaris with the extinct genera *Acanthoderma* and *Acanthopleurus*. *Glyptocephalus* occurs in the London Clay of Sheppey.

The *Gymnodontes*, or "Globe-fishes," are represented by the genus *Orthagoriscus* from the English Chalk; by *Diodon* at Monte Bolca near Verona, at Licata in Sicily, and in the Infusorial Earth at Oran in Algeria; a distinct genus, *Enneodon*, occurs at Monte Postale.

INDEX.

LIST OF SOME OF THE MORE IMPORTANT WORKS IN WHICH MANY OF THE FOSSIL FISHES IN THE BRITISH MUSEUM HAVE BEEN FIGURED AND DESCRIBED.

L. Agassiz, "Recherches sur les Poissons Fossiles," 1833–1843.

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L. C. Miall, "Sirenoid and Crossopterygian Ganoids," Mon. Pal. Soc., 1878.

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Also various papers by **Egerton, Owen, Traquair, Günther, Newton,** and **William Davies,** in "Quart. Journ. Geological Society" and in the "Geological Magazine."

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